# Preliminary Assessment and Site Inspection

# Grassy Island Disposal Facility

# Wayne County, Michigan

**—Final—**

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**U.S. Fish and Wildlife Service**
**Region 3**
**Ecological Services**
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# EXECUTIVE SUMMARY

Grassy Island is a 72-acre artificial island in the Detroit River in Wayne County, MI. The COE operated and maintained Grassy Island as a disposal facility, from 1959 – 1987, depositing dredged materials primarily from the Rouge River. From 1960 through 1982, the U.S. Army Corps of Engineers (COE) disposed of over three million cubic yards of dredged materials on Grassy Island. The materials were known to be heavily contaminated with various industrial and municipal pollutants.

The purpose of this Preliminary Assessment (PA) and Site Inspection (SI) is to assess the potential for threats to human health and the environment from contaminants located at the Grassy Island Disposal Facility (Grassy Island) and to determine the need for further response action by the Service. The scope of the PA/SI includes a review of existing information about the site, including previous sampling of sediment, biota, and groundwater on and near Grassy Island. The PA/SI evaluates the potential pathways of release via groundwater, surface water, and soils. Additionally, uncertainties about the nature and extent of potential, current, or threatened releases of hazardous substances are identified.

**Groundwater Pathway**

The groundwater on Grassy Island is likely isolated from the underlying aquifer. The most likely pathway for the release of groundwater from Grassy Island is by seepage through the dike walls into surface water. Therefore, it is not expected that releases from Grassy Island would affect surrounding groundwater resources.

**Surface Water Pathway**

There are several pathways for release of hazardous substances into the surrounding surface water. There are numerous potential targets along the Detroit River that may be adversely affected by exposure to hazardous substances. Limited groundwater data from Grassy Island indicate that many hazardous substances are at concentrations greater than drinking water criteria, GSI, and/or environmental water quality criteria. Additional data collection is required to make more quantifiable statements regarding seepage of water and contaminants through the dike walls. Frequency and volume of releases from the weir may need to be determined along with concentrations of hazardous substances in runoff from the weir. Additionally, the structural integrity of the dike walls themselves should be assessed to determine their longevity and identify preventative maintenance requirements.

**Air and Soil Pathways**

Hazardous substances were detected above state background levels in soils. Some hazardous substances were detected at levels above screening levels or some clean-up criteria, but not above Michigan's criteria for direct contact. There

is site-specific evidence of hazardous substances being present in earthworms and therefore available within a terrestrial food chain.

**Conclusions**

It is recommended that a Remedial Investigation (RI) be performed during which additional site data can be collected and/or modeling exercises conducted. As part of the RI, an environmental risk assessment should also be performed to determine risks to wildlife utilizing Grassy Island and the surrounding area. The assessment should consider risk for current site conditions and risk under future refuge management and habitat restoration scenarios. It is also recommended that a feasibility study be conducted to evaluate remedial alternatives. The results of these efforts will help make better decisions regarding the eventual remediation of contaminants and the restoration of wildlife benefits to Grassy Island.

# 1. INTRODUCTION

The purpose of this Preliminary Assessment (PA) and Site Inspection (SI) is to assess the potential for threats to human health and the environment from contaminants located at the Grassy Island Disposal Facility (Grassy Island) and to determine the need for further response action by the Service. The scope of the PA/SI includes a review of existing information about the site, including previous sampling of sediment, biota, and groundwater on and near Grassy Island. The PA/SI identifies uncertainties about the nature and extent of potential, current, or threatened releases of hazardous substances.

The PA/SI follows the process outlined in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Contingency Plan (NCP). A site description, including the history of the site, is given in Section 2. Sections 3, 4, and 5 describe the pathways for contaminant exposure to biota through groundwater, surface water, soil, and air. Section 6 is the summary and conclusions for this PA/SI.

# 2. SITE DESCRIPTION

## 2.1 Site Location

Grassy Island is a 72-acre artificial island in the Detroit River in Wayne County, MI (Figure 1). The island is located approximately 10 miles downstream from downtown Detroit and is situated east of the City of Wyandotte, west of Fighting Island (Ontario, Canada), and north of Grosse Ile (Figure 1). The geographic coordinates are 42.22357$^{o}$ North and 83.13417 $^{o}$ West.

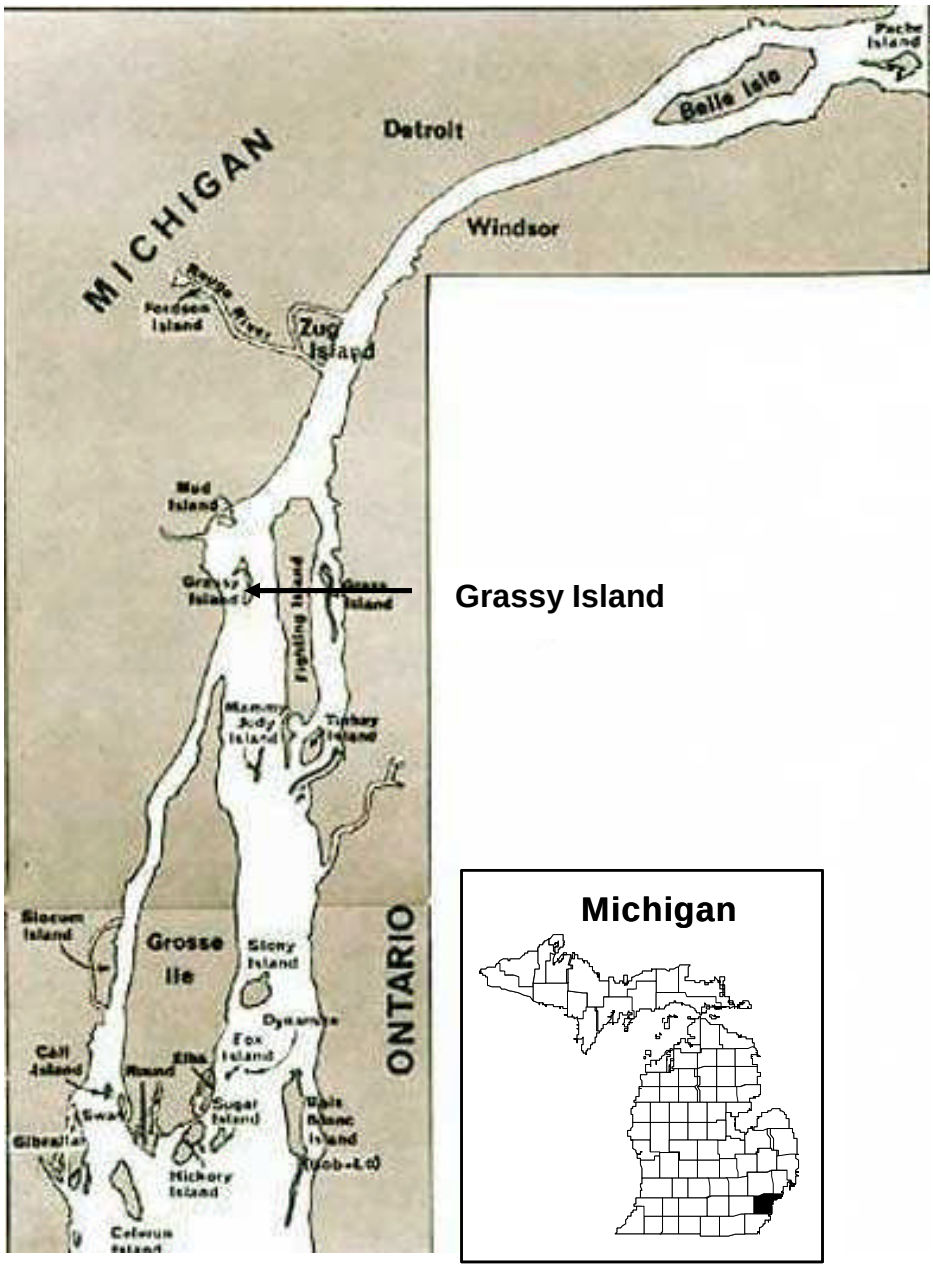



Figure 2. The Grassy Island Disposal Facility is located in Wayne County, MI in the Detroit River. Map courtesy of the Rearview Mirror, Detroit News History Site (http://www.detnews.com/history/river/river.htm)

## 2.2 Site History

From 1843 – 1961, the U.S. Treasury Department maintained jurisdiction over Grassy Island and reserved it for installation of navigational aides by the U.S. Coast Guard (U.S. Fish and Wildlife Service 2001). Until 1958, the Coast Guard was the only federal government entity to use Grassy Island. That year, the Coast Guard issued a permit to the Army Corps of Engineers (COE) to allow the COE to dispose of dredged materials on 300 acres of the Detroit River, including the Grassy Island area (U.S. Fish and Wildlife Service 2001).

In 1959, the Detroit District of the COE constructed a confining dike at Grassy Island and, in 1960, began disposing of dredged materials from the Rouge River during annual maintenance dredging. This was the first time that the COE constructed a diked disposal facility in the Great Lakes. Until the 1960's, dredged materials were disposed of in open water areas without any containment (U.S. Environmental Protection Agency 1995). Rising concern about Great Lakes water quality and possible connection to polluted sediments resulted in the COE's investigation of alternative disposal methods, including confined disposal facilities (CDFs).

In 1960, Representative John D. Dingell (D-MI) introduced legislation to designate the area as part of the National Wildlife Refuge System (managed by the Service). Congressional hearings on the proposed legislation reflected disagreement between the Service and the COE over the use of this area as a disposal site. The Service expressed strong reservations about the continued use of Grassy Island and the surrounding area as a disposal site for dredged materials because the shoals provided valuable habitat for waterfowl. The Service's concerns were based on evidence that dredge material deposition had already damaged the shoals and further disposal could destroy the habitat altogether (U.S. House of Representatives- 87th Congress, 1961). The COE deemed Grassy Island as the most appropriate disposal location due to its proximity to the dredging work and its Federal ownership (U.S. House of Representatives- 87th Congress, 1961).

In 1961, Congress passed legislation establishing the Wyandotte National Wildlife Refuge. This law effectively transferred ownership of Grassy Island and the surrounding shoals from the Coast Guard to the Service. In addition, the legislation reflected a compromise based on the conflicting interests of the COE and Service at the site. The compromise allowed the COE to continue to dispose of dredged materials on a 72-acre portion of the Detroit River, instead of the 300 acres that the COE permit originally allowed (Schaefer 1960). In turn, the COE agreed that studies of alternative disposal sites would be continued during the next 12 to 14 years to account for changing conditions and evolution in disposal methods and equipment (U.S. House of Representatives- 87th Congress, 1961).

The Detroit District of the COE operated and maintained Grassy Island from 1959 – 1987 (Hintz 2001). The COE operated Grassy Island as a disposal facility to deposit dredged materials primarily from the Rouge River (U.S. Army Corps of Engineers 1984). From 1960 through 1982, the COE disposed of over three million cubic yards of dredged materials on Grassy Island. The sediments dredged from the Rouge River were known to be heavily contaminated with various industrial and municipal pollutants (International Joint Commission 1951; U.S. House of Representatives- 87th Congress 1962). During the 1960s, at least nine plants discharged industrial waste to the Rouge River.

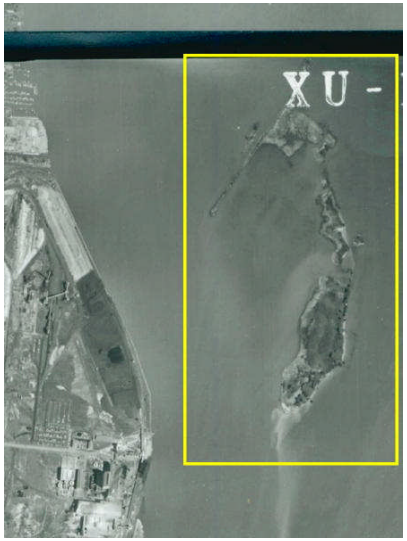
The original dike surrounding Grassy Island was 6 ft above water level and was built in 1959 from excavated river bottom material composed of uncompacted clay, sand, and gravel. Prior to construction of the dike, Grassy Island was a low lying marshy area surrounded by shoals with emergent and submerged vegetation (Figure 2A), and would have likely been delineated as a Great Lakes coastal marsh (U.S. Fish and Wildlife Service 2001). The creation of this dike transformed Grassy Island into a kidney shaped island with upland habitat (U.S. Army Corps of Engineers 1976a) (Figures 2B-D). The filling of the shoal area likely displaced fish populations, disrupted the aquatic food chain, and covered potential spawning grounds (U.S. Army Corps of Engineers 1976a).

Grassy Island was the first diked disposal facility built and operated by the COE in the Great Lakes (Great Lakes Dredging Team 2003). The facility was constructed prior to legislation and regulations regarding construction of CDFs including the River and Harbor Act of 1970 (Public Law 91-611) and Part 230 Section 404 (b)(1)[1]. The Grassy Island disposal facility was built without engineered dikes and did not incorporate the features of later structures that included liners, caps, riprap protection, etc.

During Grassy Island's use as a disposal facility, the COE was responsible for disposal operations and maintenance of the facility. In 1971, the COE increased capacity at Grassy Island by constructing an interior dike extending 20 ft above the low water datum (U.S. Army Corps of Engineers 1984). During an inspection of the newly raised dike wall, COE personnel noted that erosion was occurring along the original dike wall and that the perimeter required riprap (McCallister 1972). In 1982, a section of the south dike wall ruptured during the COE's dredged material disposal operations (Jacek 1982). Afterwards, dredge material from the Rouge River were disposed of in the Pointe Mouillee CDF located within the Pointe Mouillee State Game Area. In 1985 and 1986, the COE repaired and reinforced the dikes adjacent to the navigation channel with filter cloth and rip rap to prevent further failure (U.S. Army Corps of Engineers 1986). In 1987, the COE relinquished its right to use Grassy Island as a disposal facility (Haines 1987) and the Service began managing the island as part of Wyandotte NWR.

[1] As Grassy Island was built prior to CDF legislation and doesn't incorporate many features found in CDFs, it does not meet the legal definition of a CDF. However, historical documents refer to Grassy Island as a CDF.

Wyandotte NWR was established in 1961 and incorporated into the Detroit River International Wildlife Refuge (DRIWR) when it was established in 2001. Wyandotte NWR included both Grassy Island and the surrounding shoals to the 6 foot contour line. From 1961 to 2001, the Service managed the Wyandotte NWR as a unit of the Shiawassee NWR (located near Saginaw, MI). The original intent of the Wyandotte NWR was to provide a sanctuary for waterfowl (U.S. Fish and Wildlife Service 2001). Management objectives included the protection of existing aquatic plant beds that provided food and protection for migratory and wintering waterfowl. The Service originally met these objectives by closing the refuge to boat traffic using buoys. Buoys were placed around the Refuge boundary to warn boats away thereby preventing propeller damage to the plants and provide a resting and feeding area for waterfowl (U.S. Fish and Wildlife Service 2001). In 1973, the Service discontinued the placement of buoys due to the high cost of installation, maintenance, and frequent replacement loss or theft. The Service has not manipulated vegetation, graded soils, or conducted any other active management of Grassy Island beyond posting refuge signs on the property and conducting various surveys.




A

B

C

D

Figures 2A-D.Aerial photographs of Grassy Island from 1957 – 1987.

Figure 2A. May 1957, prior to diking by the COE

Figure 2B. Late 1960's, original 6' dike is completed

Figure 2C. July 1972, newly created inner dike and beds of emergent vegetation in the surrounding shoals.

Figure 2D. May 1985, 3 years after the last disposal operations. Island appears to be heavily vegetated.

## 2.3 Site Contamination

Grassy Island was the disposal site for dredged material, primarily from the Rouge River, during COE's annual maintenance dredging (U.S. Army Corps of Engineers 2003). From 1961 – 1982, the COE disposed of over 3 million cubic yards in Grassy Island (U.S. Army Corps of Engineers 2003). Approximately 95% of this volume came from the Rouge River. The other 5% of dredged material originated from the Detroit River and Lake St. Clair (U.S. Army Corps of Engineers 2003).

The COE dredged materials from the Rouge River with a hopper dredge. This device hydraulically dredged material while in motion (U.S. Army Corps of Engineers 1976a). Sediments from the bottom of the river were sucked up and pumped into the hoppers (storage tanks). Pumping continued until the hoppers were filled to capacity. The hoppers were equipped with overflows to allow the excess water and silt to be discharged back to the Rouge River until the predetermined load was attained (U.S. Army Corps of Engineers 1976a). Then the dredge went downstream to dispose of the materials on Grassy Island. The dredged sediments were pumped out through a discharge pipeline to Grassy Island (U.S. Army Corps of Engineers 1976a). The residue materials were flushed out of the hoppers by jets of water and the rinse water was discharged into Grassy Island (U.S. Army Corps of Engineers 1976a). Therefore, the dredged materials were discharged as a slurry of sediments and water.

At the time of disposal, the COE was aware that the sediments dredged from the Rouge River were heavily contaminated with various industrial and municipal pollutants (International Joint Commission 1951;U.S. House of Representatives- 87th Congress 1962). During the 1960's, at least nine major industrial facilities along the Rouge River discharged wastes into the watercourse including: Allied Chemical Corporation, American Agricultural Chemical Company, Darling and Company, Ford Motor Company, Peerless Cement Corporation, and Scott Paper Company (Vaughan and Harlow 1965). These facilities produced steel, fabricated metals, heavy chemicals, pulp and paper, cement, and meat-rendering products (Vaughan and Harlow 1965). The primary wastes released into the Rouge River were iron, oxygen-demanding materials, bacteria, suspended solids, oil, pickling liquor, phenols, chlorides, cyanides, toxic metals, and ammonia. These plants produced a total waste volume of 484 million gallons per day (1,832 liters per day), with 83% of the waste volume originating from the Ford Motor Company (Vaughan and Harlow 1965). A 1967 Federal Water Pollution Control Administration (FWPCA) report concluded that sediments from the Rouge River were grossly polluted containing high concentrations of oil, iron, and volatile solids (Federal Water Pollution Control Agency 1967).

In a 1976 report, the COE stated that the material dredged from the Rouge River was similar to material removed in the past and described it as sludge comprised mainly of ooze, silt, and mud (U.S. Army Corps of Engineers 1976a). The COE stated that the Rouge River sediment originated from a number of different sources, including movement from adjacent bottom materials, littoral drift, propeller wash, and bedload movement by the Rouge River during flood stage periods (U.S. Army Corps of

Engineers 1976a). The COE also stated that pollutants contained in the sediments were derived from industrial wastes, untreated or partially treated domestic wastes, urban area stormwater runoff, and wastes from vessels utilizing the waterway (U.S. Army Corps of Engineers 1976a).

*Previous Sampling Efforts*

FWPCA Pilot Study of Rouge River Dredging August - December 1967 (Federal Water Pollution Control Agency 1967)

This study was conducted by the FWPCA (precursor to the U.S. Environmental Protection Agency) during an active dredging operation on the Rouge River. One of the study's goals was to determine the degree and extent of pollution to the Detroit River resulting from the disposal of dredged material on Grassy Island.

Seepage through the dike walls was measured during active disposal operations. Seven wells were installed along the circumference of the dike, and water levels were measured during disposal operations that year. The seepage flow from the island was estimated as less than 0.2 cfs. The authors indicated that this was a low seepage rate typical of clayey subsoils (Federal Water Pollution Control Agency 1967). The water collected from the wells was determined to be grossly polluted. However, the quality of water from the Detroit River, downstream of Grassy Island, was not considered to be degraded. The quality of the pond water was compared to required and recommended effluent criteria from that time period. The concentrations of those constituents were comparable to levels allowed for other discharges into the Detroit River at the time.

COE Water Quality Monitoring (1979 – 1982) (U.S. Army Corps of Engineers 1979;U.S. Army Corps of Engineers 1980;U.S. Army Corps of Engineers 1981;U.S. Army Corps of Engineers 1982)

These studies were conducted by the COE during active dredging operations to determine if ambient water quality of the Detroit River was being adversely affected by the discharge from the disposal facility. The COE sampled a total of five stations during the monitoring studies. The five sampling stations were:

A. the pipeline discharge (dredged materials- sediment only)
B. water from the overflow area (the weir located at the northeast end of Grassy Island)
C. the plume at the discharge mixing zone within 50 ft of the weir
D. water from the Detroit River approximately 250 ft downstream from the weir discharge
E. water from the Detroit River 150 – 250 ft upstream from the weir discharge

Each year of the study, the COE took 2-3 samples from each station during dredging operations. Parameters measured included elements (arsenic, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, and zinc), polychlorinated biphenyls (PCBs), phenols, oil and grease, fecal coliform bacteria, dissolved oxygen, and total dissolved solids. A summary of key contaminants measured in the dredged materials are provided in Table 1.

The COE concluded that disposal of dredged materials on Grassy Island had little effect on downstream waters. Water collected from the weir contained lesser concentrations of all measured contaminants than did the supernatant collected from dredge material entering Grassy Island. Therefore, the COE concluded that Grassy Island trapped contaminants within its boundaries. At times, samples that the COE took from the plume had contaminant concentrations greater than those at the downstream station. However, concentrations at the upstream and downstream stations were similar, indicating rapid dilution to ambient conditions. After each study, the COE concluded that the use of Grassy Island as a disposal facility did not adversely affect the quality of the Detroit River and that the disposal facility served a beneficial purpose by containing the contaminants that would otherwise remain in the Rouge River sediments.

Table 1. Contaminants in dredged sediments (mg/kg dry weight (dw)) disposed of on Grassy Island (U.S. Army Corps of Engineers 1979; U.S. Army Corps of Engineers 1980; U.S. Army Corps of Engineers 1981; U.S. Army Corps of Engineers 1982). Cd and Fe were measured only in 1979.

| Contaminant | N | mean | min | max | std deviation |
|---|---|---|---|---|---|
| **PCB** | 10 | 3.2 | 0.31 | 11 | 3.2 |
| **Oil and Grease** | 10 | 22000 | 900 | 150000 | 44000 |
| **Phenol** | 2 | 36 | 16 | 56 | 28 |
| **As** | 11 | 22 | 2.3 | 110 | 34 |
| **Ba** | 11 | 130 | 14 | 320 | 100 |
| **Cd** | 3 | 2.8 | 0.62 | 5.9 | 2.7 |
| **Cr** | 11 | 260 | 11 | 1300 | 350 |
| **Cu** | 11 | 180 | 18 | 410 | 110 |
| **Fe** | 3 | 14000 | 6400 | 22000 | 7700 |
| **Pb** | 11 | 290 | 1.9 | 530 | 190 |
| **Mn** | 11 | 710 | 96 | 1800 | 460 |
| **Hg** | 11 | 0.79 | 0.02 | 2.1 | 0.64 |
| **Ni** | 11 | 65 | 28 | 100 | 28 |
| **Zn** | 11 | 740 | 100 | 1300 | 440 |

Survey and Evaluation of Contaminants in Earthworms and in Soils Derived from Dredged Material at Confined Disposal Facilities in the Great Lakes Region (1987) (Beyer and Stafford 1993)

A survey of nine disposal facilities in the Great Lakes region (including Grassy Island) was conducted to determine contaminant levels in co-located earthworm and soil samples. On Grassy Island, a minimum of 38 g of earthworms were collected along with a co-located soil sample. Earthworms were not depurated prior to analysis. Each soil sample comprised of 16 surface cores collected to a depth of 15 cm. Results were presented for concentrations of PCB 1254, p,p'-DDE, PAHs, arsenic, cadmium, copper, mercury, lead, and zinc (Table 2).

Earthworms from Grassy Island had greater concentrations of copper, lead, mercury, and zinc than those from any other facility surveyed in this study. Some earthworms had greater concentrations of metals than the co-located soil concentrations. Bioaccumulation factors (concentration in earthworms, dw divided by concentration in soil, dw) ranged from 1.6 – 3.5 for arsenic, cadmium, mercury, and zinc (Table 3). Bioaccumulation factors were less than one for copper, lead, PCB (quantified as PCB 1254), and PAHs (Table 3). p,p;-DDE was not detected in earthworms, so the mean BAF was < 2.4. Concentrations of contaminants in earthworms collected from Grassy Island can provide some basis for estimating exposure to higher-level consumers in food chain pathways during ecological risk assessments performed in the future.

Table 2. Contaminants in earthworms (mg/kg dw) collected from Grassy Island. All data obtained from Beyer and Stafford (1993).

| Contaminant | N | mean | min | max | std deviation |
|---|---|---|---|---|---|
| **As** | 2 | 8.1 | 7.0 | 9.2 | 1.6 |
| **Cd** | 2 | 38 | 23 | 52 | 21 |
| **Cu** | 2 | 79 | 58 | 100 | 30 |
| **Pb** | 2 | 160 | 110 | 200 | 64 |
| **Zn** | 2 | 1500 | 960 | 2000 | 740 |
| **Hg** | 2 | 1.1 | 0.51 | 1.6 | 0.77 |
| **PCB** | 2 | 0.14 | 0.03 | 0.25 | 0.16 |
| **PAH** | 2 | 7.8 | 3.5 | 12 | 6.0 |
| **p,p'-DDE** | 2 | 0.028 | 0.025 | 0.030 | 0.0040 |

Table 3. Arithmetic mean bioaccumulation factors calculated from earthworms and co-located soil samples collected on Grassy Island.

| As | Cd | Cu | Pb | Zn | Hg | PCB | PAH | p,p'-DDE |
|---|---|---|---|---|---|---|---|---|
| 2.7 | 3.5 | 0.34 | 0.33 | 1.6 | 2.1 | < 0.59 | 0.14 | < 2.9 |

Service Survey of Contaminants in Sediment and Biota (1988) (Best et al. 1992)
The Service initiated this study after the COE relinquished their right to use Grassy Island as a disposal facility. At this time, waterfowl were utilizing two areas on Grassy Island with ponded water (Dave Best, personal communication). There was concern that the ponds had the potential for being an attractive nuisance by exposing waterfowl to hazardous substances.

A sediment sample was collected from each of the two ponds. The compounds measured were total PCBs, p,p'-DDE, p,p'-DDD, chlordane, total aromatics, total aliphatics, toxic equivalents of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD-EQ) as determined by an H4IIE rat hepatoma bioassay, barium, cadmium, chromium, copper, iron, mercury, manganese, nickel, lead, and zinc. Waterfowl samples were obtained by firearms using steel shot. Species collected include Canada goose *(Branta canadensis*), mallard (*Anas platyrhynchos*), gadwall (*A. strepera*), and blue winged teal (*A. discors*). Additionally, a woodcock (*Philhela minor)* was also collected. The compounds measured in biota included total PCBs, total DDT, total aliphatics, cadmium, chromium, copper, mercury, and lead. Results are provided in Table 4. Waterfowl collected from Grassy Island had PCB concentrations in excess of the U.S. Food and Drug Administration's Tolerance Level for poultry in interstate commerce. This report concluded that contaminants were available to biota on Grassy Island and that these contaminants posed a risk to the Service's trustee resources. Results from this study will be useful in determining risk to waterfowl during ecological risk assessments performed in the future.

Table 4. Contaminants data in waterfowl liver tissue (mg/kg wet weight (ww)) collected from Grassy Island. All data obtained from Best et al. (1992).

| | mean | N | min | max | std deviation |
|---|---|---|---|---|---|
| **Cd** | 0.60 | 14 | 0.03 | 2.9 | 0.78 |
| **Cr** | 0.60 | 14 | 0.42 | 1.1 | 0.16 |
| **Cu** | 20 | 14 | 1.9 | 53 | 15 |
| **Pb** | 1.1 | 14 | 0.21 | 5.2 | 1.4 |
| **Hg** | 0.40 | 14 | 0.04 | 2.1 | 0.55 |
| **Aliphatics** | 0.43 | 15 | 0.09 | 1.1 | 0.30 |
| **Total DDT** | 0.09 | 15 | 0.01 | 0.6 | 0.14 |
| **PCB** | 0.68 | 15 | 0.03 | 2.5 | 0.84 |

Results of the Trenton Channel project sediment surveys 1993-1996. (Ostaszewski 1997).

This study was conducted by the Michigan Department of Environmental Quality (MDEQ) to assess distribution of contaminated sediments in the Trenton Channel. Sediment samples were collected from 84 different sampling stations in depositional areas and five of those were located within 400m of Grassy Island (Table 5). All five sampling stations were identified as having sediments that were impacted by contaminants, as were 78 of the other 79 sediment sampling sites in the Trenton Channel. Heavy metal concentrations did not exceed guidance levels at any of the five sampling areas adjacent to Grassy Island. However, PCB concentrations did exceed guidance levels at three of the sites and PAH concentrations exceeded guidance levels at all five sites. None of the depositional areas adjacent to Grassy Island were identified as either a major depositional area or as an extremely contaminated smaller depositional area of the Trenton Channel in the MDEQ survey.

Continuous Seismic-Reflection Profiling Near Grassy Island, Wyandotte Unit of Shiawassee National Wildlife Refuge, Wyandotte, Michigan (1996) (Sweat 1999a).

This study was conducted by the U.S. Geological Survey (USGS) Water Resources Division (WRD) and was funded by the Service. Continuous seismic-reflection profiles were collected along the shoals of Grassy Island to map the water-sediment interface and details within the sediments. Results indicate that the river sediments are most likely a clay or of high-percentage clay composition. Extrapolation of results underneath Grassy Island, indicate that Grassy Island is situated on approximately 15 – 20 m (49 – 65 ft) of native glaciolacstrine clays. The bedrock is of the Paleozoic, Devonian, or Detroit River Group dolomites. The bedrock is only occasionally fractured (primarily north of Grassy Island) and the bedrock underlying Grassy Island did not appear to be fractured or cavernous. The sediments and bedrock under Grassy Island are not conducive to the ready flow of fluids.

Contaminant Distribution in Sediments and Groundwater on and Near Grassy Island (1997) (Sweat 1999b)

This study was conducted by the USGS WRD and funded by the Service. The two objectives of the study were to characterize the chemical composition and distribution of contaminants in sediments at various depths and locations on the island, and to investigate the potential for contaminant transport in groundwater. Eight soil samples, two offshore sediment samples, and seven samples of water were collected to analyze for contaminants. Samples were analyzed for PCBs, 5 pesticides (including DDT metabolites), 28 semivolatile organic compounds (including pyrene and benzo(a)pyrene), 4 volatile organic compounds (including acetone and zylene), and 9 metals (including lead and mercury).

Concentrations of contaminants in the sediment downstream of Grassy Island are presented in Table 5. Concentrations of contaminants in the groundwater samples are presented in Table 6 and concentrations of contaminants in soil samples are combined with those from other studies in Table 7. Groundwater data from four locations on Grassy Island were analyzed. For samples that did not have measurable levels of

contaminants (non-detects), half of the detection limit was calculated. This data were then used to calculate mean contaminant concentrations as summarized in Table 6. Zn and Fe were detected in all samples. As, Ba, Cd, Ni, and Hg were not detected in 50% or more of the samples,.

Groundwater height was measured and was greatest in the inner dike areas, intermediate between the inner and outer dike, and lowest in the Detroit River (Figure 3). The data indicate that a hydraulic gradient may exist in which water flows from the inner island towards the Detroit River. Most contaminants detected in sediments and water were not detected in the island parent materials or in water from the Detroit River immediately downstream from Grassy Island. Therefore, this report concluded that contaminants on Grassy Island are contained in the sediments on the island and are not moving from the island to the surrounding sediments or waters at detectable levels. This report also concluded that it was likely that precipitation onto the island is transported into permeable surface materials. The precipitation then evaporates into the atmosphere or is incorporated into vegetation instead of percolating into the deeper layers of the dredged material and contributing to groundwater flow.

Table 5. Results of Detroit River sediment sampling surrounding Grassy Island. The site locations are ordered with upstream sites first and downstream sites last (north is upstream and south is downstream of Grassy Island). The sediment samples were taken using different methods including: cores, petite ponar, and Peterson grab. Results are presented in units of mg/kg dry weight. Samples with non-detects (ND) are noted and the detection limit is indicated in parentheses.

| Contaminant | MannyUp[a] | N. East[b] | N. West[b d] | West[b] | S. East[b] | S. West[b] | 7GI13[c] | MannyDown[a] |
|---|---|---|---|---|---|---|---|---|
| **Total PCB** | ND | 0.61 | ND (0.33) | ND (0.33) | 0.43 | 0.41 | ND (0.067) | ND |
| **Total PAH** | 12.9 | 6.62 | 1.99;5.33 | 16.07 | 32.1 | 23.1 | ND (0.33) | 2.5 |
| **As** | 4 | 4.6 | 4.5;4.0 | 2.6 | 4.5 | 5.3 | ND (0.010) | 3 |
| **Cd** | ND | 2.2 | 3.3;1.4 | 2.3 | 3.4 | 3.3 | | ND |
| **Cr** | 10 | 18 | 29;13 | 22 | 83 | 24 | ND (10.0) | 10 |
| **Cu** | 21 | 20 | 35;14 | 27 | 32 | 44 | | 12 |
| **Fe** | 7300 | 13000 | 17000;9400 | 15000 | 16000 | 14000 | 19021.3 | 8700 |
| **Hg** | 0.1 | 0.16 | 0.33;0.031 | 0.14 | 0.33 | 0.39 | ND (0.2) | ND |
| **Mn** | 120 | 260 | 350;230 | 180 | 260 | 350 | 372.2 | 120 |
| **Ni** | 8 | 21 | 44;18 | 26 | 49 | 18 | | 12 |
| **Pb** | 18 | 20 | 31;9.1 | 20 | 33 | 39 | ND (3.0) | 9 |
| **Zn** | 47 | 61 | 100;38 | 73 | 110 | 110 | | 41 |

[a] Manny 1999b (surficial sediments collected with Peterson grab)
[b] Ostaszewski 1997 (northern samples taken via cores, all others using ponar)
[c] Sweat 1999 (core samples)
[d] The results for the core sample at this location are given for the 0-30 cm depth and the 30-71 cm depth range.

Table 6. Groundwater data (µg/l) collected on Grassy Island. All data were obtained from Sweat (1999b).

| Contaminant | N | mean | min | max | std deviation |
|---|---|---|---|---|---|
| **Total PCB** | 4 | 4.5 | 3 | 7.3 | 1.9 |
| **Al** | 4 | 2000 | 100 | 3900 | 1600 |
| **As** | 4 | 11 | 5 | 29 | 12 |
| **Ba** | 4 | 147 | 100 | 290 | 95 |
| **Ca** | 4 | 360000 | 95000 | 520000 | 190000 |
| **Cd** | 4 | 3.0 | 2.5 | 4.3 | 0.9 |
| **Cr** | 4 | 25 | 5 | 51 | 20 |
| **Cu** | 4 | 48 | 13 | 85 | 31 |
| **Fe** | 4 | 28000 | 440 | 62000 | 28000 |
| **Hg** | 4 | 0.13 | 0.10 | 0.24 | 0.07 |
| **K** | 4 | 14000 | 6100 | 27000 | 8800 |
| **Mg** | 4 | 160000 | 120000 | 230000 | 51000 |
| **Mn** | 4 | 1800 | 220 | 3900 | 1800 |
| **Na** | 4 | 95000 | 28000 | 170000 | 58000 |
| **Ni** | 4 | 32 | 20 | 46 | 14 |
| **Pb** | 4 | 34 | 1.5 | 64 | 29 |
| **Zn** | 4 | 4000 | 99 | 15000 | 7600 |
| **Phenol** | 4 | 5 | 5 | 5 | 0 |
| **2-methyl-naphthalene** | 4 | 7 | 5 | 13 | 4 |
| **Acenaphthene** | 4 | 5.8 | 5 | 8 | 1.5 |
| **Phenanthrene** | 4 | 8.3 | 5 | 12 | 3.8 |
| **Methylene Chloride** | 4 | 32 | 24 | 50 | 12 |
| **Acetone** | 4 | 21 | 5 | 43 | 19 |
| **2-butanone** | 4 | 5 | 5 | 5 | 0 |

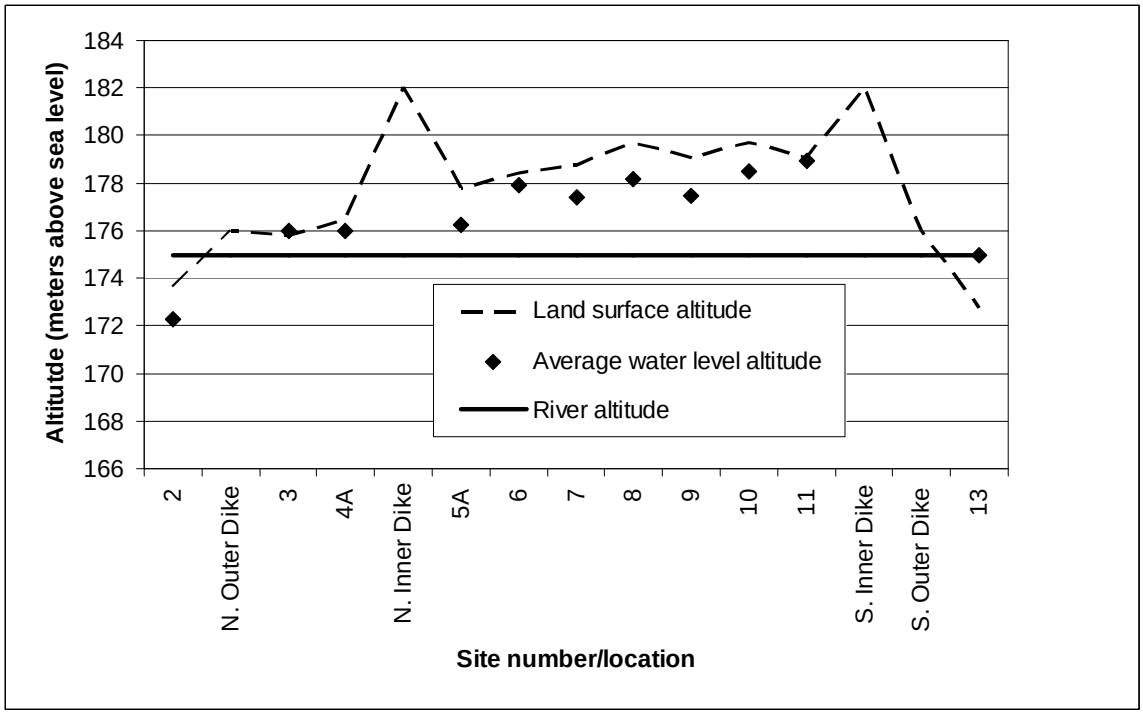



Figure 3. The generalized cross-section of Grassy Island showing average water levels in piezometers, land surface altitude, and average Detroit River altitude (May-June, 1998). Figure directly from (Sweat 1999b) pg 8.

Contamination of Surface Soils and Wild Celery Tubers at Grassy Island in the Wyandotte National Wildlife Refuge in the Detroit River, Michigan (1997) (Manny 1999b)

This study was conducted by the USGS Biological Resources Division (BRD) and funded by the Service. The objectives of this study were to distinguish "hot spots" of contaminated soil from potentially cleaner soils on Grassy Island and to determine if river sediments and wild celery tubers (*Vallisneria americana*) growing near the island were contaminated. Concentrations of contaminants in the sediment downstream of Grassy Island are presented in Table 5. 41 surface soil samples were collected using a grid overlay. The soil samples were analyzed for PCBs, PAHs, and 30 elements (including cadmium, lead, and mercury). A summary of these results are presented in Table 7, along with those from the studies previously discussed. For samples that did not have measurable levels of contaminants (non-detects), half of the detection limit was calculated. These data were then used to calculate mean contaminant concentrations as summarized in Table 7. In many samples, antimony, arsenic, mercury, selenium, and thallium were not detected.

Table 7. Summary of contaminants data for soil samples from Grassy Island.

| Contaminant | N | mean | min | max | std deviation | References |
|---|---|---|---|---|---|---|
| **Total PCB** | 80 | 3.5 | 0.13 | 19 | 3.3 | a, b, c, d |
| **Total PAH** | 50 | 34 | 6.5 | 83 | 17 | a, b |
| **Ag** | 48 | 2.6 | 0.25 | 5 | 1.6 | b |
| **Al** | 76 | 10100 | 100 | 22000 | 5900 | b, c |
| **As** | 78 | 6.4 | 0.05 | 23 | 6.0 | a, b, c |
| **B** | 48 | 42 | 5 | 63 | 12 | b |
| **Ba** | 48 | 183 | 33 | 310 | 72 | b |
| **Be** | 48 | 1.8 | 1.0 | 3 | 0.57 | b |
| **Ca** | 48 | 56000 | 24000 | 140000 | 15000 | b |
| **Cd** | 52 | 9.8 | 1.0 | 19 | 5.5 | a, b, d |
| **Cl** | 48 | 200 | 20 | 370 | 100 | b |
| **Co** | 48 | 9.5 | 3.0 | 16 | 3.4 | b |
| **Cr** | 30 | 110 | 5.0 | 306 | 120 | c, d |
| **Cu** | 52 | 210 | 37 | 360 | 99 | a, b, d |
| **Fe** | 78 | 44000 | 50 | 75000 | 18000 | b, c |
| **Hg** | 80 | 0.63 | 0.05 | 1.4 | 0.43 | a, b, c, d |
| **K** | 48 | 1900 | 450 | 3600 | 890 | b |
| **Mg** | 48 | 51000 | 14000 | 84000 | 15000 | b |
| **Mn** | 78 | 910 | 7.5 | 14000 | 1500 | b, c, d |
| **Mo** | 48 | 8.6 | 2.5 | 23 | 4.1 | b |
| **Na** | 48 | 180 | 92 | 370 | 56 | b |
| **Ni** | 50 | 67 | 13 | 100 | 26 | b, d |
| **P** | 48 | 1600 | 250 | 2700 | 620 | b |
| **Pb** | 80 | 310 | 1.5 | 2000 | 280 | a, b, c, d |
| **Sb** | 48 | 6.5 | 2.0 | 16 | 3.2 | b |
| **Se** | 76 | 6.6 | 2.5 | 34 | 6.6 | b, c |
| **Si** | 48 | 870 | 480 | 1900 | 280 | b |
| **Sn** | 48 | 27 | 2.5 | 50 | 14 | b |
| **Sr** | 48 | 76 | 40 | 110 | 20 | b |
| **Ti** | 48 | 220 | 84 | 370 | 59 | b |

Table 7. Continued

| Contaminant | N | mean | min | max | std deviation | References |
|---|---|---|---|---|---|---|
| **Tl** | 48 | 5.7 | 5.0 | 16 | 2.4 | b |
| **V** | 48 | 28 | 6.0 | 82 | 13 | b |
| **Zn** | 80 | 820 | 10 | 2000 | 550 | a, b, c, d |
| **benzo(a)anthracene** | 28 | 6600 | 170 | 32000 | 9200 | c |
| **benzo(b)fluoranthene** | 28 | 5500 | 170 | 22000 | 6100 | c |
| **benzo(a)pyrene** | 28 | 6100 | 170 | 29000 | 7700 | c |
| **benzo(k)fluoranthene** | 28 | 5473 | 170 | 22000 | 6100 | c |
| **dibenz(a,h)anthracene** | 28 | 2500 | 170 | 35000 | 6600 | c |
| **Indeno(1,2,3-c,d)pyrene** | 28 | 12000 | 170 | 170000 | 32000 | c |
| **naphthalene** | 28 | 4700 | 170 | 14000 | 4900 | c |
| **phenanthrene** | 28 | 16000 | 170 | 170000 | 34000 | c |
| **pyrene** | 28 | 12000 | 170 | 66000 | 17000 | c |

a. Beyer and Stafford 1993
b. Manny 1999b
c. Sweat 1999b
d. Best *et al*. 1992

## 2.4 Known Releases

On November 6, 1982, a 25' section of the south dike wall ruptured during the COE's dredged material disposal operations (Jacek 1982). After an inspection of Grassy Island to determine the extent of damage, the COE determined that the dike failure resulted from vegetation disrupting the drainage pattern. This disruption of the drainage pattern caused the discharged water to pond and subsequently overtop the dike wall (Jacek 1982). The dike wall was too weak to hold the weight of the water behind it. The water came out with force great enough to remove the limited riprap protection on the base of the island in front of the break (Jacek 1982). Pressure cracks were also observed along the entire southwestern section of Grassy Island (Jacek 1982). No information is available regarding how much material from Grassy Island was released into the Detroit River. The COE stopped disposing of dredged materials on Grassy Island after this incident.

The COE repaired the damaged dike walls by 1986. At this time, COE also reconstructed other dike walls due to concerns about their ongoing stability. The southwestern corner of the dike (including the area that breached) was repaired by the reconstruction of a 100 foot section using ~200 cubic yards of clay and stone (U.S. Army Corps of Engineers 1986). Additionally, the north, east, and south perimeter dike walls were also reconstructed. After the dikes were graded to a uniform surface, ~25,000 square yards of filter cloth were placed on the dikes (U.S. Army Corps of Engineers 1986). Approximately 15,400 tons of mattress stone was placed on the filter cloth and overlain with approximately 16,500 tons of armor riprap (U.S. Army Corps of Engineers 1986).

## 2.5 Regulatory History

The COE received a permit from the Coast Guard in 1958 to dispose of dredged materials in a 300 acre area in the Detroit River (U.S. Fish and Wildlife Service 2001). The 300 acres included Grassy Island and the surrounding shoals. This area became a National Wildlife Refuge in 1961, as described in the Site History section.

In 1979, the Michigan Department of Natural Resources approved Federal Water Pollution Control Act (FWPCA; Clean Water Act) Section 401 certification for the COE's dredging project on the Rouge River. In the approval letter, Michigan certified that the project would comply with the State's water quality standards. This permit was for both the dredging and disposal operations by the COE. Therefore, this was the basis of the water quality monitoring conducted by the COE at Grassy Island.

In 1987, COE relinquished its right to use Grassy Island as a disposal facility. In 1989, representatives from the Service (including Ecological Services and Refuges) conducted an on-site inspection to determine current conditions on

Grassy Island. The Service and COE met to discuss those conditions and if the site was currently adequate for refuge management. The COE and the Service agreed that contaminants analyses would be necessary prior to deciding appropriate remediation measures.

In 2000, the Service referred its studies of Grassy Island (conducted 1989 – 1999) to the U.S. Environmental Protection Agency (U.S. EPA) for programmatic review and technical assistance. These reports were also presented to the Michigan Department of Environmental Quality (MDEQ). After reviewing the Service's reports, U.S. EPA stated that the contaminated sediments, which compose Grassy Island, could present a risk to Service trust resources including the resident wildlife and migratory waterfowl of Grassy Island.

The Detroit River is one of 43 areas that have been designated by the International Joint Commission as a Great Lakes Area of Concern (AOC). AOCs are geographic areas within the Great Lakes Basin that are known to have beneficial uses that are impaired. Remedial Action Plans (RAPs) identify specific impairments and describe methods for correcting them. The Detroit River RAP was completed in 1996 and identified 9 impairments to beneficial use. In the RAP, Grassy Island was considered as one of the candidate sites for habitat rehabilitation/enhancement.

Grassy Island has been submitted to U.S. EPA for inclusion on the Federal Agency Hazardous Waste Compliance Docket (docket). The U.S. EPA listed Grassy Island on the docket on July 19, 2004, U.S. EPA ID # MIN000509025. The docket is a comprehensive record of those federal facilities where hazardous waste is managed; from which contaminants have been released; or from which there is the potential for a release of contaminants into the environment. As a result of this docket listing, the U.S. EPA is currently evaluating Grassy Island for potential inclusion on the National Priorities List.

This PA/SI is one step in a process to address the risks that contaminants in Grassy Island might pose. The remedial process described in the National Contingency Plan (40CFR300**.**420) is being used as the framework for remediation and restoration of Grassy Island.

# 3. Groundwater Pathway

## 3.1 Hydrogeologic Setting

Hydrology is the science of water occurrence, movement and transport. Hydrogeology is the part of hydrology that deals with the occurrence, movement and quality of water beneath the Earth's surface.

*Geology*

Southeastern Michigan, including Grassy Island, has a comparatively flat and featureless topography because of its geological history as glacial lakebed

(Twenter 1975). The glacial lakebed deposits in the area surrounding Grassy Island range in thickness from absent or very thin up to 6 m (20 ft) thick (Sweat 1999a). These glacial deposits are likely water-worked deposits that are a heterogeneous mixture of clay, silt, sand, and gravel (Twenter 1975). Bedrock formations under these glacial deposits are likely of the Detroit River Group dolomites from the Devonian System of the Paleozoic Age (Twenter 1975). A thin layer of riverine sediments overlay the glacial deposits or, when glacial deposits are absent, bedrock (Sweat 1999a).

*Groundwater Occurrence*

Grassy Island has a perched water table which is at or near the surface in many places (Sweat 1999b). Water levels were measured in the Detroit River, between the outer and inner dike, and within the inner dike in 1997 (Sweat 1999b). In general, groundwater levels in the river sediments were lower than those in the material contained between the dikes. Likewise, water levels in the materials between the dikes were lower than were water levels in the materials within the inner dike (Figure 3) (Sweat 1999b)).

Detroit River Group dolomite bedrock formations may also contain water. Groundwater in these formations is contained by a confining layer (Twenter 1975). A confining layer is geologic material that hampers the movement of water into and out of an aquifer. In the bedrock foundations under Grassy Island, the confining layer is the clay material within the glacial deposits. Wells drilled into Detroit River Group dolomite bedrock formations usually yield water that is too highly mineralized for most purposes (Twenter 1975). The “Swan well” on Grosse Ile yielded the greatest quantity of groundwater of all of the wells that tapped the bedrock in the area. However, water from the Swan well was highly mineralized and not of potable quality (Wisler et al. 1952). Therefore, water from these aquifers is not used for drinking water, but may be used for cooling purposes (Wisler et al. 1952). To support this generalization, there are two wells within 4 miles of Grassy Island, but neither are designated for household use (Michigan Department of Natural Resources 2003).

*Groundwater Movement*

The parent materials underneath the dredged materials were identified as glaciolacustrine clays and are likely 15 – 20 m (49 – 65 ft) thick (Sweat 1999a). These clays have a very low hydraulic conductivity. Additionally, the bedrock underlying Grassy Island is not expected to be fractured or cavernous. Therefore, it is unlikely that groundwater from Grassy Island could infiltrate into underlying bedrock aquifers. The potential of groundwater to seep through the dike walls and enter the Detroit River is discussed in Section 4.2.

### 3.2 Targets

According to the U.S. EPA, the primary risk to be assessed relating to the groundwater pathway is through human drinking water and therefore to the populations relying on groundwater as their source of drinking water (U.S. Environmental Protection Agency 1991). Therefore, the primary targets are water wells used for human consumption. While there are 2 wells within 4 mi of Grassy Island, they are not used for human consumption (Michigan Department of Natural Resources 2003). The surrounding population obtains drinking water from surface water from the Detroit River. Therefore, the most likely pathway for human exposure to groundwater from Grassy Island would likely be through releases into the Detroit River. As such, the groundwater results are put in the context of surface water and the analytical results are discussed in the surface water pathway section.

### 3.3 Analytical Results

A limited number of Grassy Island groundwater samples have been analyzed for the presence of hazardous substances (Sweat 1999a). These analyses are discussed along with the surface water sample analyses in Section 4.4.

### 3.4 Conclusions

The groundwater on Grassy Island is likely isolated from the underlying aquifer. The most likely pathway for the release of groundwater from Grassy Island is by seepage through the dike walls into surface water. Therefore, it is not expected that releases from Grassy Island would affect surrounding groundwater resources.

## 4. Surface Water Pathway

### 4.1 Hydrology

The probable point of entry of released materials from Grassy Island into surface waters would be into the Detroit River. The Detroit River is approximately 3.3 km wide at Grassy Island but is divided into three major channels by Grassy Island and Fighting Island. Grassy Island is approximately 0.5 km from the U.S. shoreline and 0.6 km from Fighting Island. The Detroit River is approximately 52 km (32 miles) long with a maximum width of 3 km (1.9 miles) (Environment Canada 1994). The river has an average flow of 5,300 cubic meters per second. The change in water elevation is 1 m and the average flushing rate is 20 h (Environment Canada 1994). There are very few sediment depositional areas remaining along the Detroit River and most material gets transported through the river into Lake Erie (Environment Canada 1994).

## 4.2 Pathways for Potential Release

*Flooding*

Flood frequency has not been determined and no flood insurance map exists for Grassy Island. However, the flood boundary and floodway maps for the City of Wyandotte (Panel number 260246 0001 B) and the northern section of Grosse Ile (Panel number 260227 0005 B) were examined as a surrogate. At both locations, the 100 year floodplain extends 10-50' inland at many areas that are adjacent to the Detroit River. Based on elevations from these maps, the 100 year floodplain on Grassy Island would likely end at the interior dike which is 20' high.

*Seepage through dike walls*

The dikes surrounding Grassy Island may be effective at containing contaminants to a significant extent. Yet some contaminants can partition into groundwater within the site, seep through the dike wall, and be released into the adjacent surface water. Contaminants which are highly soluble in water are most likely to be released through this route, whereas less soluble contaminants like PCBs tend to adsorb to organic matter in soil and sediments and are therefore less likely to be released with groundwater.

Data are limited in regards to seepage through the dike walls. There are conflicting reports regarding the presence of wells in the dike walls to measure seepage. A 1976 report indicates that wellpoints were not built in the dikes and no samples were ever taken to determine if seepage actually occurs (U.S. Army Corps of Engineers 1976b). However, a 1967 report indicates that wells were installed and the rate of seepage flow was calculated (Federal Water Pollution Control Agency 1967).

According to the report by the FWPCA (1967), the seepage rate was estimated as less than 0.2 cfs during active dredging operations and the water collected was considered grossly polluted. This seepage rate was considered low and consistent with seepage rates of clayey subsoils (Federal Water Pollution Control Agency 1967). This study is not representative of current conditions on Grassy Island because large volumes of water and dredged sediment had been placed on Grassy Island just prior to measurements. For a series of major storm events to be representative of these conditions, over 26 million gallons of water would have to fall on Grassy Island. An additional difference in current conditions is that the second dike had not been built at the time of this study.

More recently, water levels were measured in the area between the inner and outer dike (Figure 3) (Sweat 1999a). Water level results indicate the possibility that contaminants move through the dike walls into the Detroit River. However, most contaminants reported in the soils on Grassy Island were not detected in the water of Detroit River (Sweat 1999a). This study concluded that

contaminants were likely confined within Grassy Island and not measurably released through groundwater.

The different conclusions from the two studies are likely explained by differences in sampling technique and site conditions. The USGS study did not take water samples from within the dike walls. Instead, contaminant concentrations from sediments and water within Grassy Island were compared to concentrations in underlying parent materials and to water of the Detroit River immediately downstream of Grassy Island. The large dilution potential in the Detroit River would make it difficult to detect contaminants entering into the river. Additionally, the seepage rate is likely influenced by the quantity of water placed onto the island surface. The 1967 seepage study is not representative of current conditions on Grassy Island because large volumes of water and dredged sediment had been placed on Grassy Island just prior to measurements.

*Water overflow and runoff*

Water from Grassy Island can also enter the Detroit River through runoff over the dike walls or through a weir. The weir was most likely constructed when the inner dike walls were built in 1971and is located in the northeastern corner of the Island. Water from the weir discharges within 10 ft of the island and 3 ft below the surface (U.S. Army Corps of Engineers 1976b). Previously, water was discharged from Grassy Island through an overflow pipe located on the northwestern corner. Water was released into the Detroit River during disposal operations. From 1975 – 1982, the COE monitored water quality during active disposal periods. Prior to 1978, samples were only taken at the weir and upstream and downstream locations in the Detroit River. From 1978 – 1982, contaminant concentrations were also measured inside the disposal facility at the point of dredge material deposition and in the plume (mixing area) in the Detroit River. Additionally, as time progressed, more contaminants were measured. Prior to 1978, most measurements focused on phosphorus, fecal coliform, and ammonia. The trend for chemical concentrations was: dredge supernatant >> weir overflow > plume > or = to downstream conditions (U.S. Army Corps of Engineers 1979;U.S. Army Corps of Engineers 1980;U.S. Army Corps of Engineers 1981;U.S. Army Corps of Engineers 1982). Additionally the concentrations of most contaminants in the Detroit River upstream and downstream of Grassy Island were similar to one another.

*Catastrophic dike failure*

A catastrophic dike failure would be any event that causes a breach in one of the dike walls. A dike wall failed in 1982 during disposal operations (Jacek 1982), and the volume of sediments released from that event is unknown. The dike wall that failed was repaired and other dike walls were reinforced in 1986 (U.S. Army Corps of Engineers 1986). However, no information is available concerning the life expectancy of those repairs or what preventative maintenance needs to be performed to ensure dike wall stability. In the future, dike failure could result from the gradual deterioration of the dike wall combined with environmental stresses

such as large storm events or ice scouring. Additionally, a ship could collide with the island due to the island's proximity to shipping channels. The eastern side of Grassy Island is only 50 feet from the shipping channel and the shoal north of Grassy Island is in line with downbound traffic entering the Fighting Island Channel. Although ships have been grounded on the shoals surrounding Grassy Island, no ship has collided with the island itself (Manny 1999a).

## 4.3 Targets

*Sensitive Environments*

A sensitive environment is defined as a terrestrial or aquatic resource, fragile natural setting, or other area with unique or highly-valued environmental or cultural features (U.S. Environmental Protection Agency 1991). For the surface water pathway presented in this report, sensitive environments must lie either in or adjacent to the Detroit River and downstream of Grassy Island. Typically, areas that fall within the definition of "sensitive environment" are established and/or protected by State or Federal law. Examples include national parks, habitats of threatened or endangered species, and wildlife refuges (U.S. Environmental Protection Agency 1991).

On the U.S. side of the border, there are three sensitive environments found along the Detroit River within 15 miles downstream of Grassy Island (Great Lakes Commission 2000a;Great Lakes Commission 2000b;Great Lakes Commission 2000c). These areas include parcels within the DRIWR, Humbug Marsh, and Pointe Mouillee State Game Area (Figure 4). However, there are two other areas of special note due to their ecological significance or status as publicly owned parks (Figure 4). These areas are Elizabeth Park and Lake Erie Metropark. No tribal areas are found along the Detroit River within 15 miles downstream of Grassy Island (Great Lakes Commission 2000d). There are also no tribes with fishing rights on the Detroit River (John Leonard, FWS, personal communication.

The area within the DRIWR expansion boundary includes islands, coastal wetlands, marshes, shoals and riverfront lands along 18 miles of the Lower Detroit River in Michigan. In May 2003, the DRIWR expansion boundary was extended along the Lake Erie coastline to the Ohio/Michigan border and now encompasses an area of approximately 77,000 acres. The expansion area encompasses numerous coastal marshes and sensitive wetlands that might be suitable for management activities and land acquisition. The DRIWR is the first international wildlife refuge and is one of only a few refuges situated in a major metropolitan area. Currently, properties owned by the Refuge include Grassy Island, Mamajuda Island (usually submerged), Mud Island, Calf Island, and the Brancheau Tract (Doug Brewer, Service, personal communication), totaling 658 acres. The Service has permits on another 653 acres (Gary Muelenhardt, Service, personal communication).

Hennepin Marsh is a 105 acre marsh located on the northwest shore of Grosse Ile and is the most northernly identified sensitive area within the Trenton Channel. The marsh is owned by the Grosse Ile Nature and Land Conservancy. The Grosse Ile Nature and Land Conservancy, Township of Grosse Ile, and the COE are initiating a restoration plan for the marsh. The goals of the restoration plan are to restore coastal emergent vegetation and to restore the marsh to its natural integrity, employing shoreline protection measures to protect the marsh from future erosion, wave wash, and subsidence.

Humbug Marsh is one of the few remaining large wetlands found along the Detroit River within 15 miles downstream of Grassy Island. Humbug Marsh is located on the American side of the Detroit River and is 13 km (~8 miles) downstream from Grassy Island. This area provides important habitat for fish, raptors, and other wildlife. The area has an extensive walleye run which attracts hundreds of fishermen (personal observation). The property was purchased by the Trust for Public Land (TPL) in 2003. TPL is a nonprofit organization for land conservation.

Pointe Mouillee State Game Area is located at the mouth of the Huron River at Lake Erie, at the boundary between Wayne and Monroe counties. It is approximately 22 km (~14 miles) downstream of Grassy Island. It consists of a series of dikes encircling fields, marshes, bayous and other wetlands. The Pointe Mouillee CDF is located with the game area boundaries. Celeron Island is also part of the state game area, is surrounded by submerged/emergent wetlands, and is located approximately 21 km (~13 miles) downstream of Grassy Island.

Elizabeth Park is a 162-acre park located on the lower Detroit River in Trenton, Michigan. It is the oldest county park in Michigan. Elizabeth Park has approximately 3,500 feet of river shoreline and has a canal running through the park that carries flow from the Detroit River. The park is located 10 km (6 miles) downstream of Grassy Island. Funding was secured in 2003 for shoreline improvements using soft-engineering methodologies.

Lake Erie Metropark is located 16 km (10 miles) downstream from Grassy Island. This park consists of 1,607 acres with 3 miles of Lake Erie shoreline. It is a popular bird-watching site, and an abundance of wildlife and waterfowl inhabit the meadows, marsh and lagoons. The park is also heavily used by migrating waterfowl in the spring and fall, and by birds of prey in the fall.

On the Canadian side of the Detroit River, there are a number of sensitive environments within 15 miles downstream of Grassy Island. However, these areas are not designated as national or provincial parks or refuges. Instead, the sensitive environments in the area consist of islands, shoals, coastal wetlands, and marshes.

The Detroit River Marshes are located between Fighting Island and the Canadian mainland. This area has a very diverse assemblage of flora and fauna and is used by fish as spawning and rearing habitat. However, it is unlikely that contaminants from Grassy Island could be transported to the Marshes due to its position east of Fighting Island. Contaminants from Grassy Island would have to enter the Fighting Channel and move upstream. A scenario in which this could occur is if the contaminant was floating and there was a strong wind.

Turkey Island is a 120 acre island located southeast of Fighting Island. Turkey Island has a shallow underwater shelf surrounding it and the shelf is covered with an established submerged bed of macrophytic vegetation (U.S. Environmental Protection Agency 1996). The island was recently purchased by a group of Detroit-area investors who said they plan to use the island and surrounding water as a hunting preserve (Detroit Free Press 2003).

The Canard River Mouth Marsh is an extensive wetland area covering approximately 1,000 acres near the Canard River at the junction of the Detroit River. Approximately 50% of marsh is open water, interspersed with areas of cattail and water lily. The area is an important site for waterfowl and shorebird migration during spring and fall (Environment Canada 1994).

A portion of Fort Malden National Historic Park is located along the Detroit River at the southwestern end of Bois Blanc Island. The island is a well known spawning area for white bass and most of the Detroit River white bass fishery is concentrated in this area (Environment Canada 1994). Further south from Bois Blanc Island is the White Sands Essex County Recreational Area

Mans Marsh is a coastal wetland located near where the Detroit River empties into Lake Erie. Mans Marsh is approximately 135 acres in size, and approximately 65% of the area is marsh.

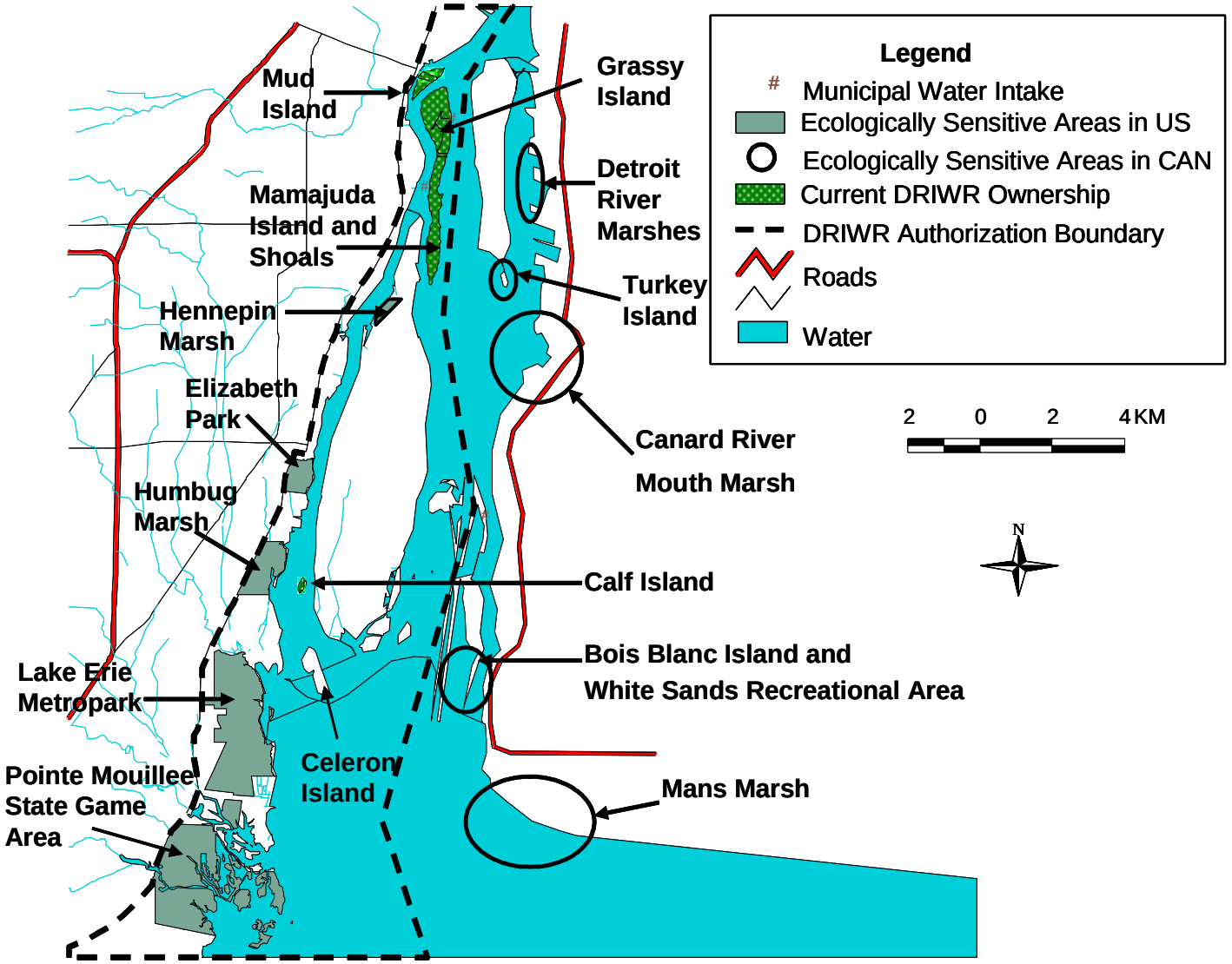



Figure 4. Locations of sensitive environmental areas along the the Detroit River within 15 miles downstream of Grassy Island. The locations of the three municipal water intakes within 15 miles downstream of Grassy Island are also shown.

*Threatened and Endangered Species*

The lake sturgeon (*Acipenser fulvescens*) is listed as a threatened species by the State of Michigan and is therefore protected in the Michigan waters of the Great Lakes under the Michigan Endangered Species Act of 1994. This species is also a Resource Conservation Priority species for Region 3 of the Service (U.S. Fish and Wildlife Service 2002). The river bottom northeast of Grassy Island is thought to have been an historic lake sturgeon spawning area (Hintz 2001). In May 2002, fishermen reported catching two lake sturgeon in the upper Trenton Channel between Grassy and Mud Islands (Bruce Manny, USGS, personal communication). The Service and USGS have implanted ultrasonic tags in approximately 20 sturgeon in the Detroit River, but have yet to locate any in the vicinity of Grassy Island (Bruce Manny, personal communication). Given that areas around Grassy Island provide rocky bottom substrate preferred by spawning lake sturgeon and the past observations, the potential for sturgeon use of the area continues to exist.

The bald eagle (*Haliaeetus leucocephalus*) is listed as a threatened species by the federal government and the State of Michigan. Although bald eagles have breeding areas near several of the identified sensitive environments, Grassy Island is not within the foraging distance of any current bald eagle breeding areas on the American side of the Detroit River (Dave Best, Service, personal communication). However, the Grassy Island area may be used by foraging bald eagles outside of the breeding season, particularly in winter. Bald eagles have been observed perched on Grassy Island (Dave Best, personal communication). In winter, bald eagles may be attracted to the shoal areas surrounding Grassy Island both for the fish and the wintering waterfowl.

*Waterfowl*

The Detroit River is an important waterfowl migration corridor situated at the intersection of the Atlantic and Mississippi Flyways. This area is heavily utilized by migratory waterfowl, including but not limited to canvasback (*Aythya vallisneria*), redheads (*A. americana*), greater scaup (*A. marila*) lesser scaup (*A. affinis*), mallards (*Anas platyrhynchos*), blue-winged teal (*A. discors*), green-winged teal (*A. crecca*), black duck (*A. rubripes*), pintail (*A. acuta*), and bufflehead (*Bucephala albeola*) (Manny *et.al* 1988). Historically and presently the marshes of the Detroit River are important spring, fall and winter staging, feeding and resting areas for waterfowl, especially canvasbacks, redheads and scaups (Manny *et.al* 1988). The Michigan Department of Natural Resources conducts yearly waterfowl surveys in November. From 1995 – 1999, an average of 15,700 individuals of waterfowl were observed each November (U.S. Fish and Wildlife Service 2001). As a result of the large numbers of waterfowl present, the Detroit River is a popular spot for duck hunting.

*Fisheries*

The area surrounding Grassy Island provides a diversity of aquatic habitats ranging from shallow cobble shoals with thick vegetative beds and low flow to deep areas with riprap shoreline, featureless bottom and high current flow (Hintz 2001). In 2001, an assessment of fish communities in the waters surrounding Grassy Island found that the area supports a warm water fish community dominated by members of the sunfish (Centrarchidae) and minnow (Cyprinidae) families. Additionally there is a balanced representation from a variety of feeding guilds (benthivores, piscivores, and omnivores were abundant) (Hintz 2001). A 1985 study found that the waters immediately downstream from Grassy Island had the greatest catch per unit effort and the second greatest total number of fish species of the eight Detroit and St. Clair River sites studied (Haas et al. 1985).

There are approximately 60 fish species that make use of the Detroit River. 32 species are permanent residents; another 28 species are migrant that use the river as a feeding, spawning, or nursery ground or as a migratory pathway between Lakes Erie and Huron (Manny et al. 1988). In 2002, approximately 433,000 fish were harvested from the Detroit River by non-commercial anglers (Thomas and Haas 2004). The Detroit River does not have a commercial fishery. White bass, walleye, and yellow perch are important recreational species that spawn in the Detroit River (Manny et al. 1988). An estimated 10 million adult walleye enter the Detroit River each year to spawn (Bruce Manny, USGS, personal communication). The Detroit River is internationally recognized as a walleye fishing area and fishermen converge on this fishery from all over the United States and Canada each spring (Bruce Manny, USGS, personal communication).

*Municipal Water Intakes*

There are two municipal water intakes adjacent to or within 15 miles downstream of Grassy Island within U.S. waters and one within Canadian waters (Environment Canada 1994). The closest is less than 150m from the northeast corner (just upstream) of Grassy Island (Figure 4). This water intake is owned and operated by the Detroit Water and Sewerage Department (DWSD). The second municipal water intake is located 1.1km downstream from the southwest corner of Grassy Island (Figure 4). This water intake is owned and operated by the City of Wyandotte, Department of Municipal Service. The furthest municipal intake is approximately 6.5 miles (10km) away from Grassy Island and serves Amherstburg, Ontario. All other water intakes downstream from Grassy Island serve industrial purposes.

The DWSD is the third largest water and sewer utility in the United States. DWSD provides water service (including drinking water) to approximately one million people in Detroit and three million people in neighboring southeastern Michigan communities throughout Wayne, Oakland, Macomb, St. Clair, Lapeer, Genesee, Washtenaw and Monroe counties. The 1,013-square-mile water

service area, which includes Detroit and 125 suburban communities, makes up approximately 43 percent of Michigan's population. The water intake near Grassy Island is only one of DWSD's intakes and this intake serves approximately 430,000 people (George Ellenwood, DWSD, personal communication).

The City of Wyandotte municipal water utility serves 11,142 consumers. The water intake 1.1 km downstream of Grassy Island is the only City of Wyandotte water intake designated for municipal drinking water. The City of Wyandotte also owns another water intake 2 km downstream from the southwest corner of Grassy Island but it is not used for drinking water.

The Amherstburg, Ontario municipal intake provides water for approximately 20,000 people in the Amherstburg area. The intake is located near Crystal Bay, north of Amherstburg.

## 4.4 Surface Water Analytical Results

No samples of surface water on Grassy Island have been taken. In the past, large pools of water were present on the island. These pools had disappeared by the spring of 2003 (Stephanie Millsap, Service, personal observation). The areas previously inundated with water were covered by giant reed grass (*Phragmites australis*).

Groundwater from Grassy Island has the potential to be released to the surface waters of the Detroit River. Therefore the available groundwater data, presented previously in Table 6, is compared to criteria for surface water and for the groundwater surface water interface (GSI). In order to identify which contaminants require further attention, concentrations of hazardous substances in groundwater were compared to various state, federal, and Canadian drinking water standards and environmental quality quidelines (Table 8). Specifically, data were compared to Michigan's drinking water criteria and GSI criteria (Michigan Department of Environmental Quality 2002), U.S. EPA primary and secondary drinking water standards (U.S. Environmental Protection Agency 2002a), U.S. EPA recommended water quality criteria (U.S. Environmental Protection Agency 2002b), and Canadian Environmental Quality Guidelines (Canadian Council of Ministers of the Environment 2002) for drinking water and aquatic life.

The exceedance values (EVs) presented in Table 9 were calculated for each contaminant by dividing the site-specific concentration by the relevant criterion. If the EV is less than 1.0, then the site-specific concentration was less than the screening/criteria level. If the EV is equal to 1.0, then they are exactly the same. However, if the EV is greater than 1.0, then the site-specific concentration exceeds the screening/criteria value. EVs are presented for contaminants which had both site-specific groundwater concentration data and available screening/criteria values.

The only hazardous substances that did not exceed any criteria were Ba, Mg, Na, acetone, and 2-butanone. All other measured hazardous substances exceeded one or more criteria (Table 9). The exceedances ranged from being at a criterion (acenaphthene) to 400 times greater (Al) (Table 9). All criteria were exceeded by total PCBs, Al, Fe, and Pb.

Detection limits for Cd and Hg were at or above criteria concentrations and had many samples at or above the detection limit. Therefore, EVs greater than 1 for these contaminants may be an artifact of the analytical detection limit. Additionally, the State of Michigan uses methyl mercury (the most toxic form of mercury) as their basis for setting the GSI criterion. As only total mercury was measured, there is no way of knowing what form of mercury was present in the samples.

Table 8. Drinking water standards and/or environmental quality guidelines used for comparison to concentrations of hazardous substances measured on Grassy Island (all units are in µg/l).

| | MI Groundwater Surface Water Interface[a] | MI Res and Comm I drinking water criteria[a] | MI Industrial &Commercial II, III, IV drinking water criteria[a] | U.S. EPA National Primary Drinking Water Standards[b] | U.S. EPA National Secondary Drinking Water Standards[b] | Canadian EQG drinking water[c] | U.S. EPA recommended Freshwater CCC[de] | Canadian EQG aquatic life[c] |
|---|---|---|---|---|---|---|---|---|
| Total PCB | 0.2 | 0.5 | 0.5 | 0.5 | NA | NA | 0.014 | NA |
| Al | NA* | 50 | 50 | NA | 50-200 | 100 | NA | 5-100 |
| As | 50 | 50 | 50 | 10 | NA | 25 | 150 | 5 |
| Ba | 4400 | 2000 | 2000 | 2000 | NA | 1000 | NA | NA |
| Ca | NA | NA | NA | NA | NA | NA | NA | NA |
| Cd | 2.4 | 5 | 5 | 5 | NA | 5 | 0.25 | 0.017 |
| Cr | 11 | 100 | 100 | 100 | NA | 50 | NA | NA |
| Cu | 9 | 1000 | 1000 | 1300 | 1000 | 1000 | 9 | 2-4 |
| Fe | NA | 300 | 300 | NA | 300 | 300 | NA | 300 |
| Hg | 0.0013 | 2 | 2 | 2 | NA | 1 | 0.77 | 0.1 |
| K | NA | NA | NA | NA | NA | NA | NA | NA |
| Mg | NA | 400000 | 1100000 | NA | NA | NA | NA | NA |
| Mn | 3600 | 50 | 50 | NA | 50 | 50 | NA | NA |
| Na | NA | 120000 | 350000 | NA | NA | 200000 | NA | NA |
| Ni | 520 | 100 | 100 | NA | NA | NA | 52 | 25-150 |
| Pb | 10 | 4 | 4 | 15 | NA | 10 | 2.5 | 1-7 |
| Zn | 1200 | 2400 | 5000 | NA | 5000 | 5000 | 120 | 30 |
| Phenol | 210 | 4400 | 13000 | NA | NA | NA | NA | 4 |
| 2-methyl-naphthalene | NA | 260 | 750 | NA | NA | NA | NA | NA |
| Acenaphthene | 19 | 52 | 150 | NA | NA | NA | NA | 5.8 |
| Phenanthrene | 10 | 52 | 150 | NA | NA | NA | NA | 0.4 |
| Methylene Chloride | 940 | 5 | 5 | NA | NA | 50 | NA | 98.1 |
| Acetone | 1700 | 730 | 2100 | NA | NA | NA | NA | NA |
| 2-butanone | 2200 | 13000 | 38000 | NA | NA | NA | NA | NA |

[a] Michigan Department of Environmental Quality 2002
[b] U.S. Environmental Protection Agency 2002a
[c] Canadian Council of Ministers of the Environment 2002
[d] U.S. Environmental Protection Agency 2002b
[e] CCC is the criteria continuous concentration and represents a chronic (4-day) exposure period protective of freshwater organisms
* NA (not applicable) Criterion has not been developed

Table 9. Exceedance values (EVs) of hazardous substances in waters on Grassy Island calculated by dividing the mean groundwater concentration by the relevant criterion. Numbers in bold indicate exceedances.

| | EV for MI Groundwater Surface Water Interface[a] | EV for MI Res and Comm I drinking water criteria[a] | EV for MI Industrial &Commercial II, III, IV drinking water criteria[a] | EV for U.S. EPA National Primary Drinking Water Standards[b] | EV for U.S. EPA National Secondary Drinking Water Standards[b] | EV for Canadian EQG drinking water[c] | EV for U.S. EPA recommended Freshwater CCC[de] | EV for Canadian EQG aquatic life[c] |
|---|---|---|---|---|---|---|---|---|
| Total PCB | **22.5** | **9** | **9** | NA | NA | NA | **320** | NA |
| Al | NA* | **40** | **40** | NA | **10-40** | **20** | NA | **20-400** |
| As | 0.22 | 0.22 | 0.22 | **1.1** | NA | 0.44 | 0.07 | ***2.20*** |
| Ba | 0.034 | 0.08 | 0.08 | 0.08 | NA | 0.15 | NA | NA |
| Ca | NA | NA | NA | NA | NA | NA | NA | NA |
| Cd | 1.3 | 0.6 | 0.6 | 0.6 | NA | 0.6 | 12 | ***180*** |
| Cr | **2.3** | 0.25 | 0.25 | 0.25 | NA | 0.5 | NA | NA |
| Cu | **5.3** | 0.05 | 0.05 | 0.04 | 0.05 | 0.05 | **5.3** | **12-45** |
| Fe | NA | **9.3** | **9.3** | NA | **9.3** | **9.3** | NA | ***9.3*** |
| Hg | **100** | 0.07 | 0.07 | 0.07 | NA | 0.13 | 0.17 | ***1.30*** |
| K | NA | NA | NA | NA | NA | NA | NA | NA |
| Mg | NA | 0.4 | 0.15 | NA | NA | NA | NA | NA |
| Mn | 0.5 | **36** | **36** | NA | **36** | **36** | NA | NA |
| Na | NA | 0.8 | 0.27 | NA | NA | 0.48 | NA | NA |
| Ni | 0.06 | 0.32 | 0.32 | NA | NA | NA | 0.62 | 0.21-**1.3** |
| Pb | **3.4** | **8.5** | **8.5** | **2.3** | NA | **3.4** | **14** | **4.9-34** |
| Zn | **3.3** | **1.7** | 0.8 | NA | 0.8 | 0.8 | **33** | ***130*** |
| Phenol | 0.02 | 0.00 | 0.00 | NA | NA | NA | NA | ***1.3*** |
| 2-methyl-naphthalene | NA | 0.03 | 0.01 | NA | NA | NA | NA | NA |
| Acenaphthene | 0.31 | 0.11 | 0.04 | NA | NA | NA | NA | ***1.0*** |
| Phenanthrene | 0.83 | 0.16 | 0.06 | NA | NA | NA | NA | ***21*** |
| Methylene Chloride | 0.03 | **6.4** | **6.4** | NA | NA | 0.64 | NA | *0.33* |
| Acetone | 0.01 | 0.03 | 0.01 | NA | NA | NA | NA | NA |
| 2-butanone | 0.0022 | 0.00 | 0.00 | NA | NA | NA | NA | NA |

[a] Michigan Department of Environmental Quality 2002
[b] U.S. Environmental Protection Agency 2002a
[c] Canadian Council of Ministers of the Environment 2002
[d] U.S. Environmental Protection Agency 2002b
[e] CCC is the criteria continuous concentration and represents a chronic (4-day) exposure period protective of freshwater organisms
* NA (not applicable) Criterion has not been developed

## 4.5 Conclusions

There are several pathways for release of hazardous substances into the surrounding surface water. There are numerous potential targets along the Detroit River that may be adversely affected by exposure to hazardous substances. Limited groundwater data from Grassy Island indicate that many hazardous substances are at concentrations greater than drinking water criteria, GSI, and/or environmental water quality criteria (Table 9). Additional contaminants data may be needed for Cd and Hg to determine if their high EVs are a result of artifacts in the analytical data.

Additional data collection is required to make more quantifiable statements regarding seepage of water and contaminants through the dike walls. More samples taken from wells on Grassy Island and its perimeter and in the Detroit River may be necessary to determine the rate of seepage under normal conditions and during rain events. Frequency and volume of releases from the weir may need to be determined along with concentrations of hazardous substances in runoff from the weir. Additionally, the structural integrity of the dike walls themselves should be assessed to determine their longevity and identify preventative maintenance requirements.

The large volume of water flowing past Grassy Island can rapidly dilute any inputs of contaminants to the river. Therefore, even if there were releases of contaminants from Grassy Island, demonstrating a difference in water quality downstream would be difficult. Future studies to determine if significant quantities of hazardous substances are being released from Grassy Island may include long-term accumulation studies. However, it may be possible to use models to estimate the magnitude of potential releases.

# 5. Soil Exposure and Air Pathways

## 5.1 Physical Characteristics

Grassy Island is an undeveloped island in the Detroit River. Currently, no public use is allowed on Grassy Island itself (U.S. Fish and Wildlife Service 2001). There are no active means to prevent people from entering the site. However, access to the island is difficult. There are two bulkhead docks on the east side, but they lie very close to an active shipping channel in a fast current. Only the southern dock has a ladder for personnel access. The shoreline is most accessible from small boats on the western (concave) shore of the island where the slopes are less steep and the current much slower. However, access to the island is still difficult due to the shallow water depth and beds of aquatic vegetation.

The island is vegetated predominately with cottonwood (*Populus deltoides*) and willow (*Salix*) trees and exotic giant reed grass. Giant reed grass is a tall grass that can attain a height of 2-4 m (6' – 12') in height and is a dense monoculture on the island, such that walking on Grassy Island is very difficult. Because of the poor access, dense vegetation, and lack of likely picnic sites, recreational boaters are not expected to stop and spend time at Grassy Island.

## 5.2 Soil and Air Targets

There are no dwellings, office buildings, schools, or other structures located on or within 200 feet of Grassy Island. Only people boating past Grassy Island would be within 200 feet of Grassy Island. Due to the difficulties in accessing the island, recreational boaters are not expected to stop and spend time at Grassy Island. However, human use of the island under future management scenarios for the island must be considered.

Previously, when large pools of water were present, numerous species of waterfowl used the island (Best et al. 1992). Best *et. al*. (1992) also collected woodcock (*Philhela minor*), a terrestrial avian species. Additionally, frogs were heard in the large pools of water (Doug Spencer, Service, personal communication). In 1988, Canada geese, mallards, gadwalls, blue-winged teals, and woodcock were observed and collected on Grassy Island (Best *et. al*. 1992). Additionally, deer, burrowing animals, and songbirds were observed on the island in 2003 (Stephanie Millsap, Service, personal observation). Therefore, there is potential for wildlife living on the island to be exposed to contaminants. Future species assemblages on Grassy Island would be dependant upon the habitat management chosen. For example, if the island were restored with wetland habitat, waterfowl and amphibians would likely inhabit the island.

## 5.3 Soil Analytical Results

In order to identify which contaminants in soil require further attention, contaminant concentrations previously presented in Table 7 were compared to various state, federal, and Canadian background levels, clean-up criteria, and screening levels. Specifically, data were compared to Michigan's generic soil clean-up criteria for direct contact at residential/commercial I and industrial/commercial II sites (Michigan Department of Environmental Quality 2002), Michigan background soil concentrations (Michigan Department of Environmental Quality 1993), U.S. EPA Ecological soil screening levels (SSLs) (U.S. Environmental Protection Agency 2000), and Canadian Environmental Quality Guidelines (EQGs) (Canadian Council of Ministers of the Environment 2002) for soil with residential/park use (Table 10).

The mean concentrations of hazardous substances measured in Grassy Island soils were compared to the various guidelines and expressed as an exceedance value (Table 11). If the EV is less than 1.0, then the site-specific concentration was less than the screening/criteria level. If the EV is equal to 1.0, then they are exactly the same. However, if the EV is greater than 1.0, then the site-specific concentration exceeds the screening/criteria value. EVs were calculated based on the concentrations of chemicals for which both site-specific soil concentration data and SSLs were screening/criteria values were available (Table 11).

All of the contaminants measured on Grassy Island exceeded Michigan's background concentrations for soil (Table 11). The EVs based on background soil concentrations that were above one ranged from just 10% above the criterion (As) to 17 times greater (Zn). However, when compared to Michigan's Direct Contact clean-up criteria, contaminants in Grassy Island soils did not exceed any of the criteria (Table 11). Many of the contaminants were found at concentrations that were 2-3 orders of magnitude less than Michigan's Direct Contact clean-up criteria. Some contaminants also exceeded the Canadian EQG or U.S. EPA criteria.

Table 10. Soil standards, backgrounds, clean-up criteria, and/or environmental quality guidelines used for comparison to concentrations of hazardous substances measured on Grassy Island (all units are in mg/kg dw).

| Contaminant | MI Background[a] | MI Res & Comm Direct Contact[b] | MI Indus & Comm II Direct Contact[b] | Canadian EQG Res./Park[c] | U.S. EPA ECO-SSL mammalian[d] | U.S. EPA ECO-SSL plants[d] | U.S. EPA ECO-SSL soil invert[d] | U.S. EPA ECO-SSL avian[d] |
|---|---|---|---|---|---|---|---|---|
| Total PCB | NA* | 4 | 16 | 1.3 | NA | NA | NA | NA |
| Ag | 1 | 2500 | 9000 | 20 | NA | NA | NA | NA |
| Al | 6900 | 50000 | 370000 | NA | NA | NA | NA | NA |
| As | 5.8 | 7.6 | 37 | 12 | NA | 37[f] | NA | NA |
| B | NA | 48000 | 350000 | NA | NA | NA | NA | NA |
| Ba | 75 | 37000 | 130000 | 500 | 1000 | NA | 330 | NA |
| Be | NA | 410 | 1600 | 4 | 36 | NA | 40 | NA |
| Cd | 1.2 | 550 | 2100 | 10 | 0.38 | 32 | 140 | 1 |
| Co | 6.8 | 2600 | 9000 | 50 | 240 | 13 | NA | 190 |
| Cr | 18 | NA | NA | 64 | NA | 5[f] | NA | NA |
| Cu | 32 | 20000 | 73000 | 63 | NA | NA | 61[f] | NA |
| Fe | 12000 | 160000 | 580000 | NA | NA | NA | NA | NA |
| Hg | 0.13 | 160 | 580 | 6.6 | NA | NA | NA | NA |
| Mg | NA | 1000000 | 1000000 | NA | NA | NA | NA | NA |
| Mn | 440 | 25000 | 90000 | NA | NA | NA | NA | NA |
| Mo | NA | 2600 | 9600 | 10 | NA | NA | NA | NA |
| Na | NA | 1000000 | 1000000 | NA | NA | NA | NA | NA |
| Ni | 20 | 40000 | 150000 | 50 | NA | NA | NA | NA |
| P | NA | NA | 1000000 | NA | NA | NA | NA | NA |
| Pb | 21 | 400 | 900 | 140 | 59 | 110 | 1700 | 16 |
| Sb | NA | 180 | 670 | 20 | 0.29 | NA | 78 | NA |
| Se | 0.41 | 2600 | 9600 | 1 | NA | NA | NA | NA |
| Sn | NA | NA | NA | 50 | NA | NA | NA | NA |
| Sr | NA | 330000 | 1000000 | NA | NA | NA | NA | NA |
| Tl | NA | 35 | 130 | 1 | NA | NA | NA | NA |
| V | NA | 750 | 5500 | 130 | NA | NA | NA | NA |
| Zn | 47 | 170000 | 630000 | 200 | NA | 190[f] | 120[f] | NA |
| benzo(a)anthracene | NA | 20000 | 80000 | 1.0 | NA | NA | NA | NA |
| benzo(b)fluoranthene | NA | 20000 | 80000 | 1.0 | NA | NA | NA | NA |
| benzo(a)pyrene | NA | 2000 | 8000 | 0.70 | NA | NA | NA | NA |
| benzo(k)fluoranthene | NA | 200000 | 800000 | 1.0 | NA | NA | NA | NA |
| dibenz(a,h)anthracene | NA | 2000 | 8000 | 1.0 | NA | NA | NA | NA |
| Indeno(1,2,3-c,d)pyrene | NA | 20000 | 80000 | 1.0 | NA | NA | NA | NA |
| naphthalene | NA | 16000000 | 52000000 | 0.60 | NA | NA | NA | NA |
| phenanthrene | NA | 1600000 | 5200000 | 5.0 | NA | NA | NA | NA |
| pyrene | NA | 29000000 | 84000000 | 10 | NA | NA | NA | NA |

[a] Michigan Department of Environmental Quality 1993
[b] Michigan Department of Environmental Quality 2002
[c] Canadian Council of Ministers of the Environment 2002
[d] U.S. Environmental Protection Agency. 2002
[e] NA (not applicable) Criterion has not been developed
[f] U.S. Environmental Protection Agency. 2000

Table 11. Exceedance values (EVs) of hazardous substances in soils on Grassy Island calculated by dividing the mean soil concentration by the relevant criterion. Numbers in bold indicate exceedances.

| Contaminant | EV for MI Background[a] | EV for MI Res & Comm Direct Contact[b] | EV for MI Indus & Comm II Direct Contact[b] | EV for Canadian EQG Res./Park[c] | EV for U.S. EPA ECO-SSL mammalian[d] | EV for U.S. EPA ECO-SSL plants[d] | EV for U.S. EPA ECO-SSL soil invert[d] | EV for U.S. EPA ECO-SSL avian[d] |
|---|---|---|---|---|---|---|---|---|
| Total PCB | NA[e] | 0.88 | 0.22 | **2.7** | NA | NA | NA | NA |
| Ag | **2.6** | 0.001 | 0.000 | 0.13 | NA | NA | NA | NA |
| Al | **1.5** | 0.20 | 0.027 | NA | NA | NA | NA | NA |
| As | **1.2** | 0.84 | 0.17 | 0.53 | NA | 0.17[f] | NA | NA |
| B | NA | 0.001 | 0.000 | NA | NA | NA | NA | NA |
| Ba | **2.5** | 0.005 | 0.001 | 0.36 | 0.18 | NA | 0.55 | NA |
| Be | NA | 0.004 | 0.001 | 0.45 | 0.05 | NA | 0.05 | NA |
| Cd | **8.2** | 0.018 | 0.005 | 0.98 | **26** | 0.31 | 0.07 | **9.8** |
| Co | **1.5** | 0.004 | 0.001 | 0.19 | 0.04 | 0.73 | NA | 0.05 |
| Cr | **6.1** | NA | NA | **1.7** | NA | **22**[f] | NA | NA |
| Cu | **6. 6** | 0.011 | 0.003 | **3.3** | NA | NA | **3.4**[f] | NA |
| Fe | **3.6** | 0.28 | 0.076 | NA | NA | NA | NA | NA |
| Hg | **4.8** | 0.004 | 0.001 | 0.10 | NA | NA | NA | NA |
| Mg | NA | 0.051 | 0.051 | NA | NA | NA | NA | NA |
| Mn | **2.1** | 0.036 | 0.010 | NA | NA | NA | NA | NA |
| Mo | NA | 0.003 | 0.001 | 0.86 | NA | NA | NA | NA |
| Na | NA | 0.000 | 0.000 | NA | NA | NA | NA | NA |
| Ni | **3.4** | 0.002 | 0.000 | **1.3** | NA | NA | NA | NA |
| P | NA | NA | 0.002 | NA | NA | NA | NA | NA |
| Pb | **15** | 0.78 | 0.34 | **2.2** | **5.3** | **2.8** | 0.18 | **19** |
| Sb | NA | 0.036 | 0.01 | 0.33 | **22** | NA | 0.08 | NA |
| Se | **16** | 0.003 | 0.001 | **6.6** | NA | NA | NA | NA |
| Sn | NA | NA | NA | 0.54 | NA | NA | NA | NA |
| Sr | NA | 0.000 | 0.000 | NA | NA | NA | NA | NA |
| Tl | NA | 0.16 | 0.044 | **5.7** | NA | NA | NA | NA |
| V | NA | 0.037 | 0.005 | 0.22 | NA | NA | NA | NA |
| Zn | **17** | 0.005 | 0.001 | **4.1** | NA | **4.3**[f] | **6.8**[f] | NA |
| benzo(a)anthracene | NA | 0.33 | 0.083 | **6600** | NA | NA | NA | NA |
| benzo(b)fluoranthene | NA | 0.29 | 0.069 | **5500** | NA | NA | NA | NA |
| benzo(a)pyrene | NA | 3.1 | 0.76 | **8700** | NA | NA | NA | NA |
| benzo(k)fluoranthene | NA | 0.027 | 0.007 | **5500** | NA | NA | NA | NA |
| dibenz(a,h)anthracene | NA | **1.3** | 0.31 | **2500** | NA | NA | NA | NA |
| Indeno(1,2,3-c,d)pyrene | NA | 0.600 | 0.15 | **1200** | NA | NA | NA | NA |
| naphthalene | NA | 0.000 | 0.000 | **7800** | NA | NA | NA | NA |
| phenanthrene | NA | 0.010 | 0.003 | **3200** | NA | NA | NA | NA |
| pyrene | NA | 0.000 | 0.000 | **1200** | NA | NA | NA | NA |

[a] Michigan Department of Environmental Quality 1993
[b] Michigan Department of Environmental Quality 2002
[c] Canadian Council of Ministers of the Environment 2002
[d] .S. Environmental Protection Agency. 2002
[e] NA (not applicable) Criterion has not been developed
[f] U.S. Environmental Protection Agency. 2000

## 5.4 Contamination of Surrounding Sediments

The release of contaminated soil from Grassy Island into the Detroit River could result in contaminated sediments being found adjacent to and downstream of Grassy Island. Limited sampling has been conducted to determine contaminant concentrations in sediments surrounding Grassy Island (Table 5). Overall, there appears to be no trend in contaminant concentrations from upstream to downstream, with the exception of PAHs appearing to have greater concentrations downstream when compared to upstream sites (Ostaszewski 1997). However, sediments in rivers can be heterogeneous over relatively small spatial scales. More sediment data would be needed to conclusively determine if there is an upstream/downstream trend in contaminant concentrations.

Grassy Island is located within the Trenton Channel, which contains the majority of the contaminated sediments in the Detroit River Area of Concern. Areas with severely contaminated sediments are located both upstream and downstream of Grassy Island. Of the 84 sampling sites in the Trenton Channel, only one site had non-impacted sediments, while the majority of sites were classified as having moderately, extremely, or severely contaminated sediments. Based on the nature and extent of sediment contamination within the Trenton Channel, it would be difficult to determine the origin of the sediments currently surrounding Grassy Island. However, when an ecological risk assessment is conducted for the site, the surrounding sediments should also be considered for evaluation.

## 5.5 Air Monitoring

Air quality monitoring has not been reported for Grassy Island.

## 5.6 Conclusions

Hazardous substances were detected above state background levels in soils. Some hazardous substances were detected at levels above screening levels or some clean-up criteria, but not above Michigan's criteria for direct contact. Further investigation is warranted for PCBs, Cr, Cu, Ni, Pb, Se, Tl, Zn, and some semi-volatile organic compounds (polyaromatic hydrocarbons). The earthworm survey provides site-specific evidence of hazardous substances being present and therefore available within a terrestrial food chain. Although the site is located near a major metropolitan area, the site is currently relatively inaccessible.

Future risk assessments should include food chain models incorporating the earthworm data and collection of additional site-specific data as necessary. Accumulation of contaminants by plants may also need to be investigated. The assessment should include species currently inhabiting Grassy Island as well as those species that might be present as a result of restoration actions taken to achieve management goals of the DRIWR.

# 6. Summary and Conclusions

Grassy Island has been part of the National Wildlife Refuge system since 1961. The COE operated a disposal facility on the island from 1960-1987. The COE disposed of dredge materials on the island from 1960 – 1982. During this time, COE disposed of approximately three million cubic yards of contaminated sediments, primarily from the Rouge River, on the island.

Due to access difficulties, the current likelihood of human exposure to contaminated soil is probably minimal. There is a low potential for groundwater contamination off-site due to the hydrogeological properties of the area. However, soil and water criteria for PCBs, various metals (including copper, iron, lead, and zinc), and PAHs are exceeded on site. As a result, biota using Grassy Island and downstream areas and biota along the Detroit River may be adversely affected. The most likely route of release for hazardous substances is via drainage from the overflow weir into the Detroit River. Another possible route of release may be seepage through the dike walls. However, due to the large dilution factor within the Detroit River, it will be difficult to document releases or differentiate any such release from other nearby contaminant sources.

The greatest uncertainties in assessing effects of contaminants on and from this site concern the nature and extent of current or threatened releases of hazardous substances from the site via surface runoff and through dike wall seepage. Determination of whether ongoing releases are occurring at the site through dike wall seepage and surface runoff warrants further analysis. These data gaps should be addressed in a RI during which additional site data can be collected and/or modeling exercises conducted. As part of the RI, an environmental risk assessment should also be performed to determine risks to wildlife utilizing Grassy Island and the surrounding area. The assessment should consider risk for current site conditions and risk under future refuge management and habitat restoration scenarios. The results of these efforts will help make better decisions regarding the eventual remediation of contaminants and the restoration of wildlife benefits to Grassy Island.

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